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Difficulty in Processing Information about Faces Stresses Brains of Persons with ASDs

by Kris Freeman

Social interaction can be stressful for persons with autism spectrum disorders (ASDs) and recent brain imaging research by Natalia Kleinhans, Ph.D., may explain some of the underlying causes of this stress. Her work involves brain activity that occurs when people look at faces. In an experiment that involved looking at photographs of faces, adults with ASDs showed different patterns of activity than adults without ASDs in an area of the brain called the amygdala, which is involved with stress and the processing of memories linked to emotion.

Natalia Kleinhans uses functional magnetic resonance imaging to study what happens in the brain of children with autism spectrum disorders when they look at images of faces and process that information.

Kleinhans is one of several research affiliates of the Center on Human Development and Disability (CHDD) who are studying how the brain responds to images of faces in relation to ASDs. Social interaction is extremely complex, which makes studying it difficult.

"We are starting at a very basic level, with the question of what happens when you look at a face and how your brain processes that information. This helps us in our basic understanding of ASDs," said Kleinhans, a research assistant professor of radiology.

Another reason for conducting this kind of study is that it is practical with very young children. "Unlike complicated language-based social interactions, tracking how people look at faces is possible even with very young children and toddlers," she said. "They may not be able to talk, but you can see how their brains respond. So this is a really good experimental model to use across different age groups to see how it relates to clinical outcomes."

Kleinhans uses functional magnetic resonance imaging (fMRI) to study activity in the amygdala and another area of the brain known as the fusiform face area (FFA). The amygdala is a structure about the size and shape of an almond that is part of the brain's limbic system. The limbic system is involved in processing of emotion, long-term memory and olfaction (the detection and analysis of scents). The amygdala is involved in the formation and storage of memories linked to emotional events, or emotional learning. When a person forms a memory of a very happy or sad event, the amygdala is involved. The amygdala is linked to the FFA, part of the lateral fusiform gyrus, which is located in the temporal lobe. The FFA appears to process information about faces and to be involved in facial recognition.

As part of the limbic system, the amygdala is also closely linked to the hippocampus, which is important in the formation of memory. It is also connected to the hypothalamus, which is important in regulating the autonomic nervous system, the part of the nervous system that controls functions that are not under conscious control. For example, if you feel fear or anger, the hypothalamus will increase your blood pressure and rate of breathing, and the hippocampus and amygdala will work together to form and store a memory of the events that triggered your feelings and emotional response.

Previous studies have found that the amygdala develops differently in persons with ASDs than in persons without ASDs. In persons with ASDs, the amygdala grows rapidly during early development and tends to be enlarged. However, later in life, the amygdalae of persons with ASDs tend to be smaller than those of persons without ASDs. There is some speculation that over activity of the amygdala may lead to premature cell death, according to Kleinhans.

In Kleinhans's studies of facial processing, adults with and without ASDs saw a series of photographs of faces with neutral expressions. As a control, participants were instructed to stare at a fixation cross that appeared on the screen. The amygdala and FFA of all the participants activated in response to the photographs of faces. However, amygdala activity in persons without ASDs quickly decreased. In other words, brains of participants without ASD quickly got used to seeing the photographs and "their brains quieted down," said Kleinhans. This dampening in response to a stimulus that becomes routine is called habituation.

In contrast, amygdala activity in participants with ASD stayed high; they had low levels of habituation. "There was a little drop off in activity, but basically, the amygdala of these participants stayed active," said Kleinhans. The level of amygdala habituation among participants correlated with their level of social skills. Persons with the lowest levels of habituation tended to receive lower scores on tests of social skills.

Kleinhans also has found reduced communication between the FFA and amygdala in adults with ASD. "These parts of the brain don't talk to each other very well," said Kleinhans. In Kleinhans' experiments, overall levels of FFA activity in persons with ASDs were similar to those of persons without ASDs. "However, when you analyze whether the FFA is effectively interacting with the larger social network of the brain, you see some breakdown in communication between the FFA and amygdala during the processing of facial information," said Kleinhans. This means that the part of the brain that recognizes faces is having difficulty sending signals to parts of the brain that process emotion and memory.

Both of these results – lack of habituation of the amygdala and poor communication between the amygdala and FFA – indicate that the brains of persons with ASDs work harder during social interactions than the brains of persons without ASDs. The brains of persons with ASDs may also be more stressed because extended periods of amygdala activity can contribute to a stress response in the other parts of the limbic system. This stress could discourage persons with ASDs from practicing social skills, as well as contribute to their difficulty in interpreting social cues, such as facial expressions.

Like the basic research of other CHDD colleagues studying brain function and ASDs, Kleinhans' results may be used to develop tests for monitoring effectiveness of treatment. In the meantime, Kleinhans continues to study brain function in response to faces and other critical social information in an effort to identify the brain pathology underlying ASDs. In future studies, she plans to study the relationship between the amygdala and the frontal lobes of the brain, which are involved in evaluating information. For example, the frontal lobes are involved in determining whether a new situation, such as seeing a series of photographs of unfamiliar faces, is dangerous, advantageous, or neutral.

"The amygdala typically receives lots of signals from the frontal lobes. Failure to habituate might be caused by a failure of the frontal lobes to appropriately dampen the amygdala. That may be why it keeps firing away," she said.

CHDD is an interdisciplinary center dedicated to the prevention and amelioration of developmental disabilities through research, training, clinical service, and community outreach. CHDD includes the University Center of Excellence in Developmental Disabilities and the Eunice Kennedy Shriver Intellectual and Developmental Disabilities Research Center.

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